Utah Farm & Home Science Vol. 24 No. 1, March 1963

UTAH FARM HOME SCIENCE

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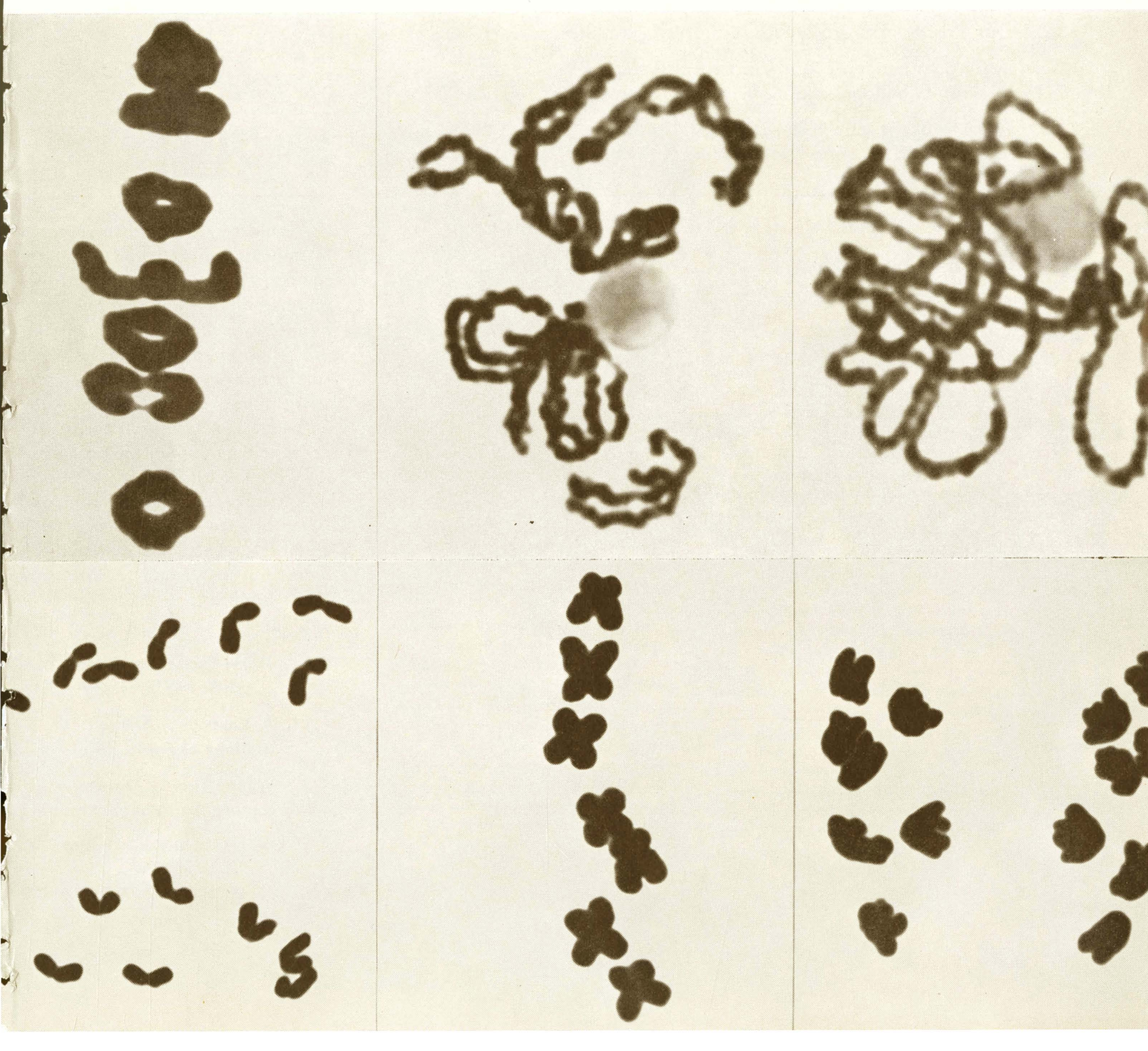
AGRICULTURAL EXPERIMENT STATION • UTAH STATE UNIVERSITY • LOGAN



FARM HOME

COVER PICTURE: Meiosis in crested wheatgrass. Chromosomes are the physical structures within the cell that bear the heditary elements, the genes. With some exceptions, each plant or animal receives its chromosomes from a maternal and paternal parent. Inasmuch as each parent contributes only half of its chromosome complement to the offspring, the chromosome number of a species remains constant from generation to generation. The process (meiosis) by which chromosome numbers are reduced to half is illustrated by the cover photographs, which are magnified 2,000 to 2,500 times. Fairway crested wheatgrass, the species represented in the photographs, has vegetative cells with 14 chromosomes. Certain 14-chromosome cells are found in the floral parts of the plant destined to give rise to gametes that will contain the reduced chromosome number, which in this case is 7. Early in the meiotic process, the chromosomes appear as long, intertwined strands that consist of 2 chromosomes paired tightly together (fig. 1). The 14 paired chromosomes become individually distinguishable as they contract (fig. 2). After further contraction, the 7 chromosome pairs align themselves near the center of the cell in preparation for the reduction division (fig. 3). Each chromosome pair then separates, and 7 chromsomes pass to opposite ends of the cell (fig. 4); and 2 daughter cells are formed, each with 7 chromosones. The 7 chromosomes realign themselves at the center of each daughter cell in preparation for a second division (fig. 5, only 1 daughter cell is shown). The chromosomes then divide (fig. 6), and 2 cells are formed from each daughter cell. Thus, one 14-chromosome mother cell gives rise to four 7-chromosome cells, which develop into sex cells. When 2 sex cells unite in fertilization, the parental chromsome number of 14 is restored.—Douglas R. Dewey.

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NEW PUBLICATIONS

Bul. 436. Alfalfa seed production studies, by M. W. Pedersen and W. P. Nye. Departments of Agronomy and Zoology in cooperation with the U. S. Department of Agriculture. 22 p.

This bulletin is divided into two parts: Alfalfa seed production as influenced by three varieties, six cultural treatments, and four growing seasons, and additional factors associated with seed yields.

Bul. 437. Federal grant lands in Utah: Management alternatives for maximizing economic returns to surface uses, by E. Boyd Wennergren and N. K. Roberts. Department of Agricultural Economics. 56 p.

This publication analyzes the questions on management of state lands and alternative programs that the State Land Board may adopt to maximize returns.

Bul. 438. Biennial report of the Agricultural Experiment Station, Utah State University, 1960-1962. 47 p.

This is a statistical report outlining the organization, the land holdings, the research projects, grants, service activities, publications, staff, and finances of the Station.

Bul. 439. Freezing temperature probabilities in Utah, by Gaylen L. Ashcroft and W. J. Derksen. Department of Agronomy.

This bulletin is the first of a proposed series on the climate of Utah. The information on freezing temperatures is based on daily records of weather stations for 30 years or more. The tables are useful for long range planning, e.g., selecting planting time relative to time required to reach maturity, selecting varieties of vegetables and fruits for home garden and orchard, selecting proper plant species for landscaping.

UTAH FARM AND HOME SCIENCE

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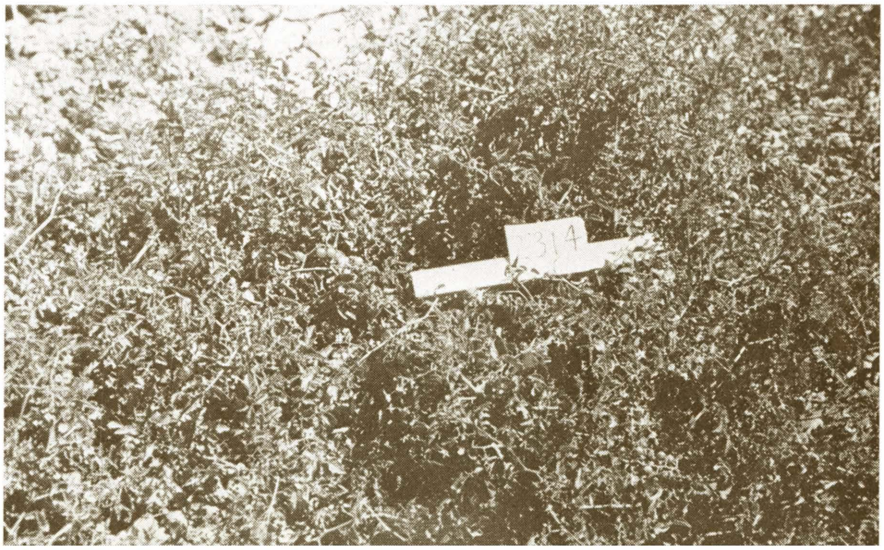
CONTROLLING TOMATO CURLY TOP BY USING RESISTANT VARIETIES

MARK W. MARTIN
ORSON S. CANNON



CURLY top disease of tomatoes causes serious losses to tomato growers and canners throughout the western states. Losses vary from year to year, but they are so great that tomatoes are not grown on a commercial scale on thousands of acres in the Intermountain area that are otherwise well suited for tomato production. In some years, losses from tomato curly top in Utah have been estimated at two million dollars. Consequently, tomato acreages are reduced because of the risk resulting from this disease. The ability to control curly top would increase tomato production in Utah and much of the rest of the Intermountain West and would increase the profits realized by those currently involved in the

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DR. MARK W. MARTIN is in charge of the tomato breeding program which is being conducted by the Crops Research Division, ARS, U. S. Department of Agriculture in cooperation with Utah State University. Dr. ORSON S. CANNON, head of the Department of Botany and Plant Pathology, was formerly in charge of the tomato breeding program and is still actively engaged in assisting with the greenhouse testing phases.

Fig. 1-4. Wild species of tomato collected in South America by Dr. H. L. Blood. These green-fruited species were found to have high levels of resistance to curly top virus, and have, subsequently, been used in tomato curly top breeding programs. 1. Lycopersicon peruvianum var. dentatum. 2. L. p. var. humifusum. 3. L. hirsutum. 4. L. pimpinellifolium.

Fig. 5-8. Moderately-resistant breeding lines developed from wild, green-fruited species by a complex series of crosses. 5. Line 22C2 derived curly top resistance from L. p. var. dentatum. 6. Line 25 derived curly top resistance from L. p. var. humifusm

7. Line 28 derived curly top resistance from L. p. var. dentatum

8. Line 193 derived curly top resistance from L. p. var. dentatum, L. hirsutum, and L. pimpinellifolium

tomato industry. Growing varieties of tomato resistant to curly top is probably the most satisfactory means of controlling this disease.

Breeding program

A tomato curly top breeding program is currently being conducted by the United States Department of Agriculture in cooperation with the Utah Agricultural Experiment Station. The purpose of this article is to describe some of the promising results being obtained from this program.

Program initiated by H. L. Blood

The late H. L. Blood initiated this breeding program in 1930 and spent the next 10 years trying to find resistance to tomato curly top. He screened every available commercial tomato variety in the world for resistance under severe curly top exposure at Hurricane, Utah; however, he found no worthwhile resistance. He also made extensive efforts to obtain resistance by selecting uninfected plants in fields which had almost 100 percent incidence of curly top. This method had proved successful in breeding for resistance to curly top in sugar beets, but he found negative results in tomatoes.

The search extended to South America

Dr. Blood eventually made a trip to South America to collect wild species related to tomato. He subsequently found high levels of curly top resistance in several of these wild, green-fruited species and he initiated an intensive program to incorporate this resistance into commerically acceptable tomato varieties. He and later workers encountered genetic barriers in this interspecific crossing program and found it difficult to retain high levels of curly top resistance in lines approaching commercial type. Results from this program during the past two years, however, indicate success in incorporating high levels of curly top resistance into tomato lines which have good horticultural characteristics.

New lines developed from three pedigrees

These promising curly top resistant lines have been developed from three general pedigrees each involving a complex series of crosses. (1) A promising group of lines, the 22C2 series (fig. 5), has curly top resistance derived from a single wild species *Lycopersicon peruvianum* var. *dentatum* (fig. 1). (2) A second series of lines involves a three-way cross designated as (25 x 28) 193. Line

25 (fig. 6) in this pedigree is a small-fruited, moderately-resistant line with poor horticultural characteristics which derives its resistance from a wild species *Lycopersicon peruvianum* var. *humifusum* (fig. 2). Line 28 (fig. 7) is of commercial type which has mild curly top resistance derived from *L. p. dentatum*. The third line in the cross, line 193 (fig. 8), has medium-sized, poor type fruit, but moderately-high levels of curly top resistance derived from three wild species, *L. p. dentatum, L. hirsutum* (fig. 3), and *L. pimpinellifolium* (fig. 4). Lines 25 and 28 in this cross are also resistant to verticillium and fusarium wilts. (3) The third group of resistant lines is designated as (45 x 28)193. In this pedigree a moderately-resistant line of *L. pimpinellifolium* (45) is used in place of the line 25 used in the previously-described three-way cross.

The three-way crosses described above have demonstrated a level of resistance which is apparently higher than that of any of the lines which are combined in their pedigree. The results of greenhouse and field tests in which the three-way cross (25 x 28)193 and each of its component lines were tested for curly top resistance are shown in table 1. Apparently, genes for resistance have been accumulated from different moderately-resistant sources to produce lines with high levels of curly top resistance.

Table 1. Response of a three way cross, (25 x 28) 193, to curly top exposure compared to that of each of the component lines which make up this three-way cross

Line	Greenhouse		Field	
	H/T*	%H†	H/T	%H
25	13/73	18	7/21	33
28	8/105	8	5/19	26
193	19/82	23	9/14	64
(25 x 28)	31/147	21	9/18	50
(25 x 28) 193	11/28	39	142/151	94

*Number of healthy plants over total number of plants
†Percentage of plants remaining healthy throughout tests

Results in 1962 indicate that lines with high levels of resistance and good horticultural characteristics have been derived from the three series of pedigrees described above by backcrossing them to susceptible commercial varieties and selecting for curly top resistance in severe greenhouse seedling tests. In these tests 2500 young seedlings are placed in an enclosed area within a greenhouse and large numbers of infective leafhoppers are released in the enclosure when the seedlings are starting to produce their first true leaves. These leafhoppers are either reared on sugar beets in the greenhouse or collected from the desert and allowed to feed on curly top infected sugar beets before they are placed in the enclosure with the tomatoes. A test about two weeks after the leafhoppers have been released is shown in fig. 9. By this time, curly top symptoms are starting to be expressed. The relative response of susceptible and resistant tomato lines about a month later is shown in fig 10. Such severe greenhouse tests have made it possible to select only those lines with

(*Continued on page* 25)

Fig. 10. Curly top response of a susceptible commercial tomato variety (center) in comparison with the response of curly top resistant lines when tested in greenhouse seedling tests

Fig. 9. Wayne Waite taking curly top readings on tomato seedlings which were fed upon two weeks earlier by infectious sugar beet leafhoppers in this greenhouse enclosure

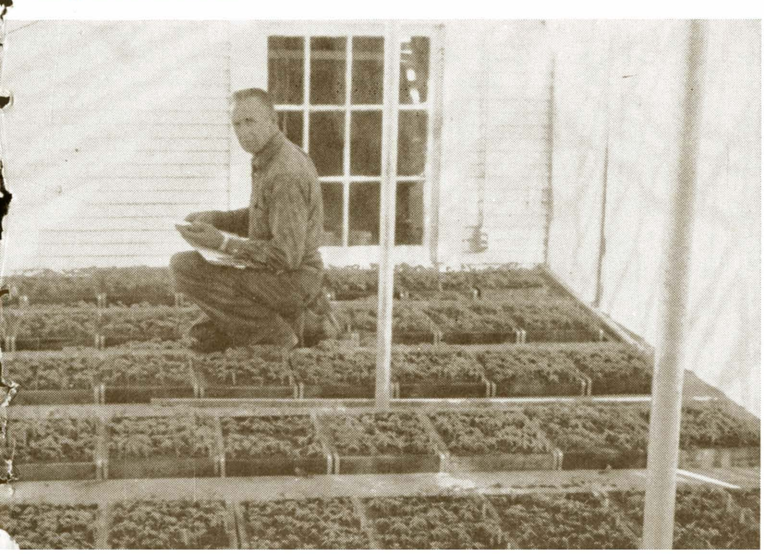

Fig. 11. Curly top response of a susceptible commercial tomato variety (left) in comparison with the response of a curly top resistant variety on the right

OUR LIMITED NATURAL

AMERICANS have characteristically tended to take for granted their vast and seemingly unbounded natural wealth of soil, water, timber, forage, and minerals. Nature has not, however, endowed us with a limitless storehouse. Today, no new land remains. Water is limited and polluted. Many of our forests are being depleted. Our ranges cannot carry the livestock. People are demanding more outdoor recreation than currently can be supplied. It is finally becoming evident that even in fabulous America resources are limited.

This is not a passing problem. All evidence points to a continued expansion in the human population.

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This is the third of the articles written for the centennial year of the land grant colleges and summarizing important past and present research in the general areas covered by the Experiment Station. These articles also point out the areas where problems exist and where future research is needed to solve them. Earlier articles discussed the plant and animal sciences. DR. L. A. STODDART has been head of the Department of Range Management since 1935 and is familiar with the problems connected with the development and preservation of our natural resources.

People demand more luxuries, not fewer, as civilization advances. The need before us, then, is to devise more efficient ways to use our limited resources.

Research geared to present population density or to present levels of demand will not solve the problems of tomorrow. At least some of these problems are predictable, and they cannot be solved in a short time. Today's research must provide answers for tomorrow's difficulties.

As one of America's land grant universities, Utah State University has consistently engaged in research designed to better the lives of Utahns in particular and Americans in general. Much of this research has dealt with natural resources. Thus, in view of the growing sense of urgency relative to these resources, it seems appropriate to review our past and present endeavors along these lines and to consider potential future developments.

Major resources with which we are most concerned are (1) land and soil; (2) water; (3) natural vegetation, including ranges and forests; and (4) wild animals, including game and fish.

Land and soil

Information about Utah's soil resource is obtained mainly by soil surveys. Surveys in Utah are part of a national program known as the National Cooperative Soil Survey. Cooperating agencies are the Agricultural Experiment Station, the Soil Conservation Service, the Bureau of Indian Affairs, the Forest Service, and the Bureau of Reclamation.

Soil surveys involve studying, identifying, and mapping soils in the field and then assembling, analyzing, and interpreting the facts about the various soils and their relations to each other. The surveys not only map the geographic distribution of soils, they tell what kinds of soils occur and how much there is of each. In addition, the soil survey facilitates interpretation and evaluation of information about the soils. This information is equally valuable to urban and suburban developments and to farmers. Federal and state agencies concerned with planning and with the management of forest and rangelands also make good use of soil survey results.

In Utah, detailed soil survey information is available for about 10 percent of the state (fig. 1). This

RESOURCES — Laurence A. Stoddart

covers essentially all cultivated or potentially cultivated land. A general soil-type map has been completed for the entire state. Detailed survey work recently has been extended into the higher mountain areas and into the western range areas.

The Station has long held a position of national leadership in basic research in soil physics. Information gathered from this work is of fundamental importance in understanding the water movement in soil. Important new concepts concern the nature of forces that bind soil particles together to form aggregates and the thermodynamics of water flow through the soil. The latter is important to basic understanding of irrigation, use of water by plants, and loss of water by evaporation.

Utah scientists have constructed an instrument which will measure the energy of water in moist soil and living biological systems. Such measurements require reduction of temperature variations to less than one-thousandth of a degree. With this temperature control, relative humidity differences as small as one-thousandth of one percent can be determined. The humidity changes are reflected in a small electrical signal which, in turn, can be related to the energy of the moisture in the soil. This instrument is now being used as a tool to help unravel the mysteries of the soil- plant system.

Our present irrigation practices are causing increases in soil lime accumulation. The resulting unavailability of iron and manganese to plants is being studied. Attempts are being made to control reaction within the soil and thus make the essential mineral elements more available to the plant.

Basic geological information of use to engineers, conservationists, agriculturists, and the mining industry has been compiled through the years. A current project, a geologic map of the James Peak quadrangle, will add to fundamental information on the geologic structure of northern Utah. It will complete the mapping of the drainage area of the Little Bear River, on which stream pollution studies are now being undertaken.

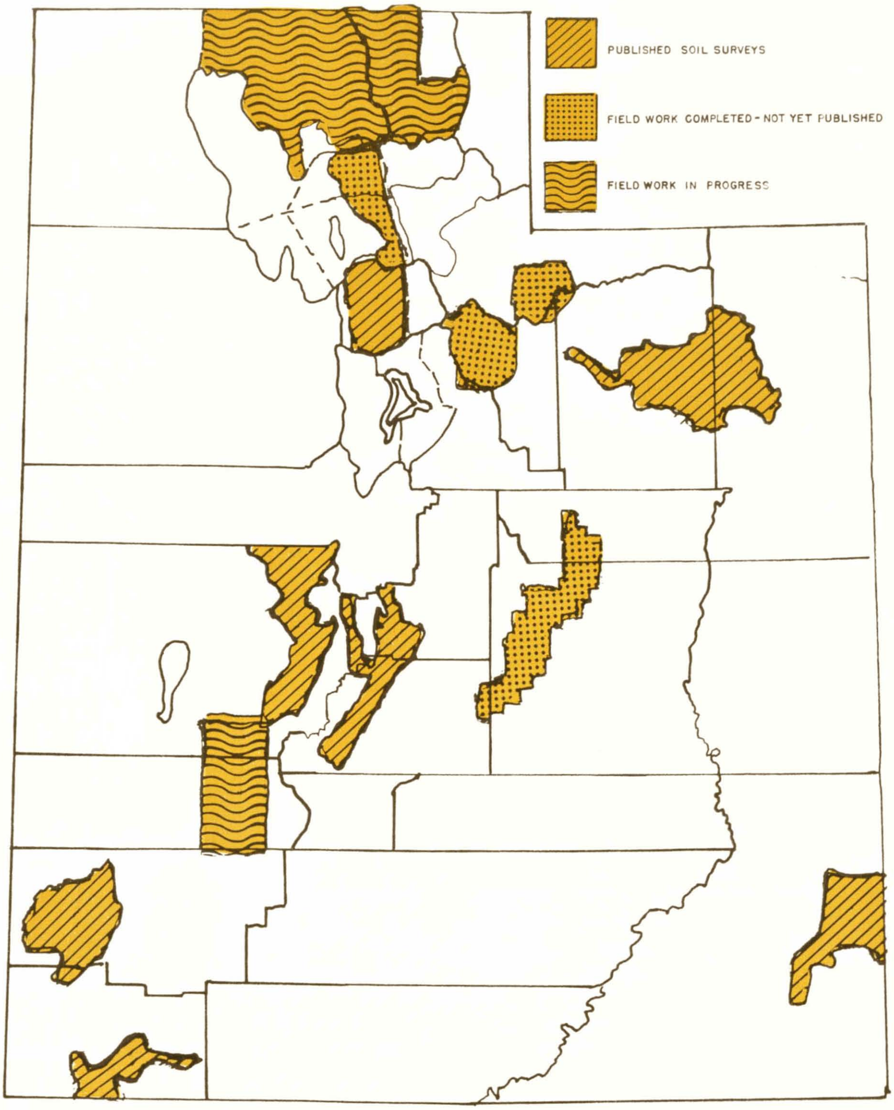
A geologic map of Cache Valley will be published soon by the U. S. Geologic Survey. This report contains important new information about ground water supplies. A continuing study, using radioactive elements in the rocks of the foothill areas, will add additional information on the configuration of the ground-water basin.

The distribution of mineral resources in various parts of Utah has been studied. Results of several of these studies are available in Station publications.

Water

Utah's most limiting natural resource is water. Essential for municipal uses, for irrigation, industry, recreation, fish, wildlife, livestock, and aesthetic purposes our water supplies warrant extensive and intensive study. To obtain more efficient water use, we need to know more about both surface and underground storage, transbasin diversion, how to increase yield by watershed management, and how to decrease pollution. Problems of water rights must be considered and solved as a basis of achieving better statewide distribution and use.

Fortunately, current developments promise tremendous opportunities for additional productive research by Utah State University scientists in this field. The Utah Water Research Laboratory, now under construction, will open new vistas. Federal money



SOIL SURVEY PROGRESS MAP- 1962

has been obtained to finance this basic research facility and, as soon as matching money is appropriated by the state, the laboratory will be completed. Agricultural, industrial, and municipal water problems will be investigated.

The Forest Sciences Laboratory to be built on the campus by the Forest and Range Experiment Station, also will facilitate broad based research into water problems. Construction of this laboratory will begin in 1963, and a sizable force of federal collaborators will be assigned to the research. Although other resource studies are included, major emphasis will be on watershed research to assure maximum high quality water flow from our mountains.

Studies have shown that Utah has a surplus of arable land in comparison with the water resources available to irrigate this land. Only about one-third of the presently irrigated land has adequate water today.

Utah State University and the State Water and Power Board have joined in proposing that the 1963 State Legislature establish a statewide water planning program which will permit better long-range planning and guide current and future use of our water. This proposal also supports the need for associated research to place state planning programs on a sound basis.

More efficient use of the water that has been developed and is now in use is critical. However, to use water more efficiently requires development of techniques, methods, and equipment, as well as the dissemination of this knowledge to the waters users. USU scientists are studying means for evaporation reduction from storage reservoirs. The Experiment Station has intensive studies on lining of conveyance channels, better control structures, improving water measurement, better methods of water management, increasing the yields of our watersheds, and drainage. Use of plastics and other materials to form catchment basins for water offers a promising new approach to conserving water. Of utmost importance is the management of our water resource in such a way that maximum multiple use is achieved and minimum pollution occurs.

New research in meteorology and climatology will aid in understanding and forecasting weather.

Wildlife

Research in wildlife resources can be divided into two phases. The early phase was concerned with providing sound, scientific answers to specific problems in the management and control of game and fish. Such studies as: the management of the Cache elk herd, the life history and management of the pintail, the management of the sage grouse, the life history and movements of the Raft River deer herd, the life history and management of the Rocky Mountain whitefish, and Bear Lake fish and fishing are examples of this type of work.

In recent years, wildlife research has shifted toward a more basic approach. Animal behavior, population dynamics, pollution biology, fish toxicology, and animal ecology are stressed rather than management of individual species of fish or game. Such studies are applicable to many species and answer fundamental questions relative to general management problems.

Rapidly increasing demand for recreational resources has led to studies involving inventory of mountain lakes and streams. Unique methods that use aerial photographs to determine lake depths and recreational potentials are being developed.

Range and forest research

The forage produced for livestock and game animals on our rangelands constitutes a vital natural resource. Basic research is being conducted on factors affecting the kind and amount of forage produced on desert ranges including soils, climate, rodent activity, grazing season, and grazing intensity.

The conflict in range use between game and livestock is being studied especially in relation to deer and antelope and range livestock. Problems of jackrabbits and other rodents on the range are also included.

Basic knowledge has been assembled on nutrition of range livestock and is being used by livestock growers throughout the world. The chemistry and digestibility of forage plants have been the basis for specific recommendations to livestock owners for feeding programs that will increase reproduction percentages, rates of gain, and wool yields. Other range research deals with the management of mountain ranges, methods of reseeding, how to graze seeded ranges, and economics of various management and improvement practices. Spring ranges are particularly critical in Utah. Research results have shown that lamb crops can be increased 20 percent and lamb gains by 8 pounds by seeding these ranges to grasses.

Considerable forest research is being directed at products marketing. One phase of the work is a study of the economics of Christmas tree production from native pinyon pine and juniper stands. Basic research is underway on growth physiology, factors affecting reproduction, and the successional patterns of important Utah timber species.

Future research opportunities

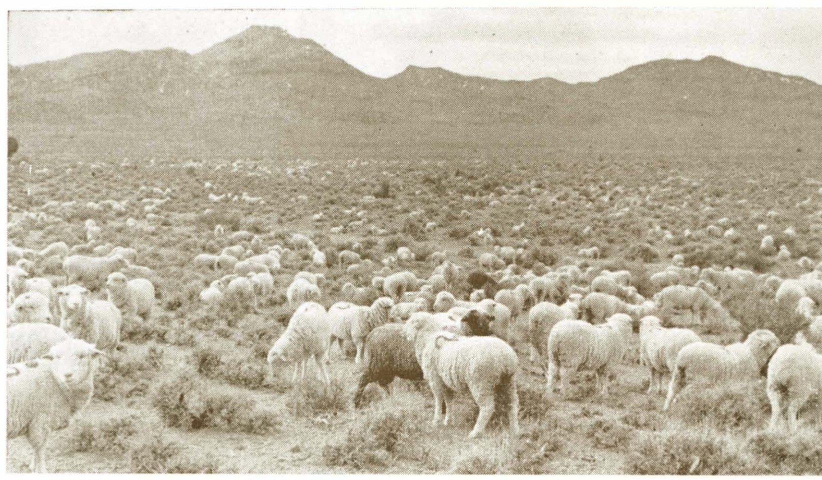
Research on natural resources offers challenging new vistas. Spectacular accomplishments will someday be reality—only time and research opportunities delay them. A few of these are mentioned.

The inevitable day when man learns the secret of the green plant—how to compound carbohydrates with the aid of the sun's energy—we shall have an almost limitless source of food as well as energy. Research in this direction has tremendous implications.

Many people are convinced that we will someday modify climate, particularly rainfall, to increase production from arid lands. Likewise, development of plants more efficient in water use and hence able to produce well under the existing aridity is a fertile field for research. Utah scientists have demonstrated that some

Improvement in quality, timing, and duration of water yield from watersheds is possible through practices based on better knowledge

About 430,000 cattle get part or all of their feed from grazing the range



As grazing permits are cut, other sources of feed must be found for range livestock if producers are to stay in business. Among these are irrigated pastures, increased production on available range through reseeding and better management practices, and higher yields of forage crops

plants are able to produce more than twice the animal forage per unit of water transpired than others. Plant breeders have a real challenge here.

Watershed management is a serious problem in Utah. We need to know how to modify mountain vegetation to assure adequate soil protection and maximum water flow. Watershed studies need to be correlated with livstock grazing research to minimize conflict between use of land for both forage and water.

Surface waters generally have been extensively exploited. Ground water, however, is little understood. We need intensive surveys to locate accurately our underground water basins. Hydrologic and geologic research is required to determine basin size, water quality, recharge rates, and development techniques. These basins may prove our most economic and efficient storage areas to stabilize seasonal supplies of water.

Research is needed to increase the efficiency of water use. We need to know how better to conduct and to store the water which we now have available. We need to know how to maximize crop production per unit of water applied. We need to know how to spread irrigation water to maintain desired salt balances in soil and how to prevent undesirable changes in soil chemistry and physics which induce impermeability and resultant drainage problems. Better understanding of soil-plant-water relations will improve water-use efficiency. Reducing evaporation losses from soil and from stored water sur-

Pinyon pines are rapidly gaining favor for use as Christmas trees in Utah and surrounding states. They offer possibilities for income from land that has few other means of economic income faces also is promising.

Most important of all is the need for safe and palatable water for human consumption. Even with present populations, about 50 percent of the drinking water available in Utah is below acceptable standards. The best efforts of biologists, chemists, and engineers are needed to satisfy our increasing demands for pure water.

Pollution is considered by some to be the major resource problem in America today. Detergents, radioactive wastes, insecticides, and herbicides are contamination sources that can affect water, soils, flora, and fauna. Problems associated with the modification of microscopic plant and animal communities are infinite. These small organisms directly affect soil production. They are directly or indirectly the food source of such animals as waterfowl and fish. In addition to the microscopic plant problem, we need to know tolerances of crop plants to pollutants in the soil and in irrigation waters. The pollution problem requires basic ecological study. All life depends upon exact habitat characteristics, yet all activities of man tend to modify the habitat within our waters and soils.

The science of reusing water must have more research. Waste water when cleaned becomes new water that can be used. Increasing demands for water to dispose of sewage and industrial waste make it necessary to find ways to repurify and reuse these waters.

Air pollution also is a mounting problem. Radioactive by-products, smoke, fluorine, and exhaust gases are examples of the contaminants that may damage plants and animals or even make air unsafe for people, especially in population centers.

Improvement of native plants by selecting suitable ecotypes and by breeding for specific qualities offers hope for increasing forage yields and for developing new ornamental uses. Better yield, palatability, nutritive value, and drought resistance are distinct possibilities.

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Inventorying water resources for recreational uses

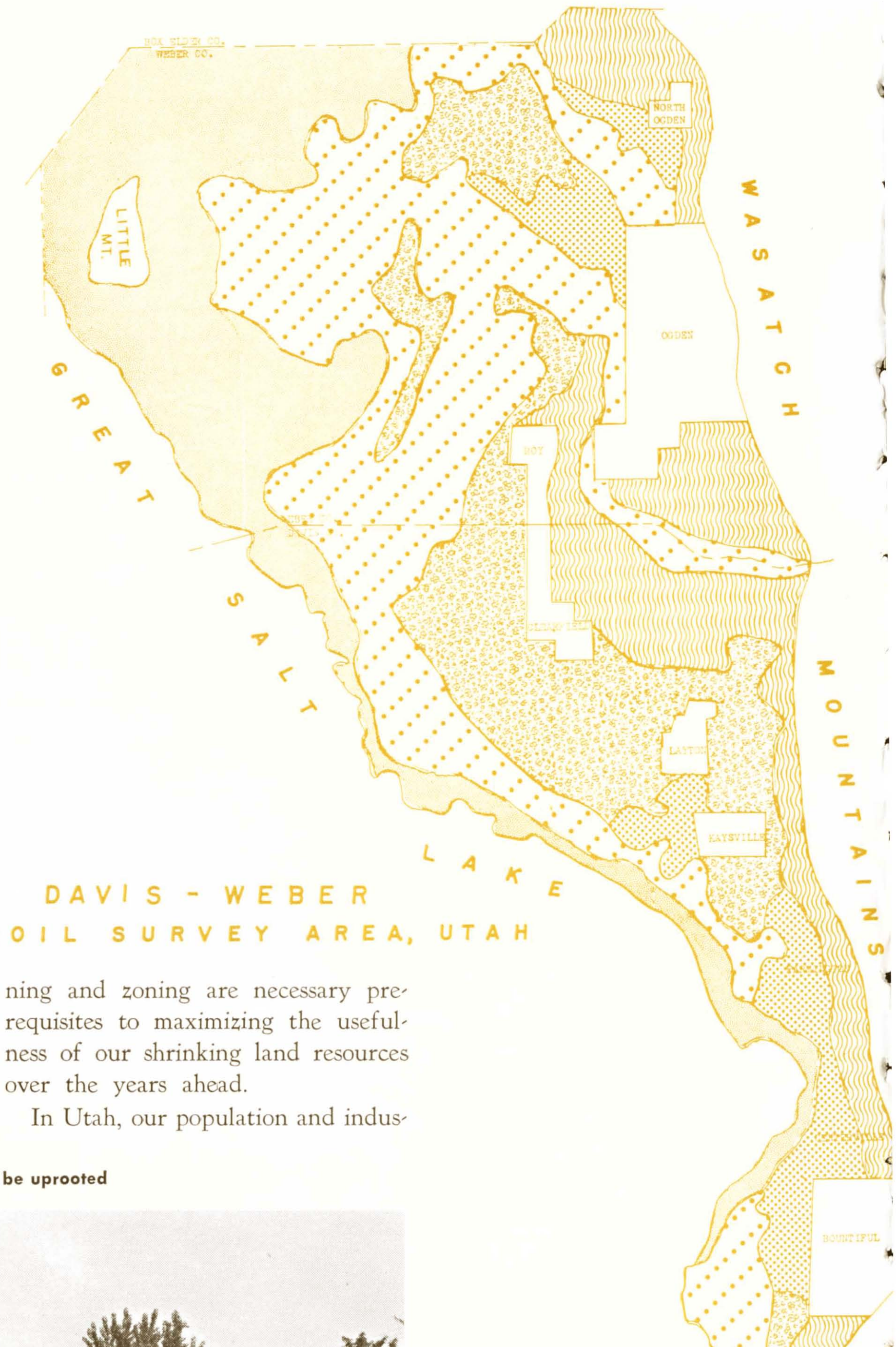
ZONING

To Conserve Our Land Resources

LEMOYNE WILSON
AUSTIN ERICKSON

URBAN and industrial expansion has removed many acres of fertile agricultural land from crop production throughout the nation. Although surpluses do exist currently in a few agricultural crops, the withdrawal of good land from agriculture at this time may have seriously detrimental effects for later generations. The haphazard patterns of all too many of these past developments ignored overall, long-range considerations. Comprehensive planning and zoning are necessary prerequisites to maximizing the usefulness of our shrinking land resources over the years ahead.

In Utah, our population and indus-



DAVIS - WEBER SOIL SURVEY AREA, UTAH

Housing is causing formerly productive orchards to be uprooted

LE MOYNE WILSON is associate professor of agronomy and in charge of the soil survey work for the Station. AUSTIN ERICKSON is soil scientist with the Soil Conservation Service stationed in Logan.

Both farmers and builders favor the deep well-drained soils that occur on the level or gently sloping lake terraces

Housing developments encroach on some of the best agricultural land

trial installations along the Wasatch Front are expanding with little previous thought as to what they will mean to future development of the state. Large acreages of fertile agricultural lands are going into roads, industrial uses, and building sites. This situation is particularly serious because only a small percentage of the state's land is well adapted to the demands of intensive agricultural production and we have so many acres of land with little or no agricultural value.

Need for zoning

There is need for zoning based on a long range view, because many of the characteristics that make a parcel of land desirable from a farming viewpoint also enhance its immediate profitability for land developers. Certainly the soil is only one of many factors that must be considered in zoning, but it is among the most basic.

Utah's soil types are many and diverse, but their individual capabilities and potentials can be sharply defined by soil surveys. These surveys delineate the important characteristics of slope, texture, stoniness, depth to bedrock or hardpan, drainage, and salt or alkali content and provide information on inferred qualities of soils such as permeability, erodability, and consistence. Such information should be available before zoning is attempted.

Soil survey information basis of planning

The complexity of the overall soil situation in Utah makes it impossible to cope with planning and zoning problems on a statewide basis. Small segments of the state where population pressures are most evident, however, can be defined and their soil resources managed now with an eye to the future. It is far more meaningful, therefore, to consider the state on the basis of such representative limited areas. The Davis-Weber area, where a soil survey has recently been completed, can serve as an example to illustrate how survey information can function in planning for the future.

Recent industrial, military, and commercial expansion within Davis and Weber Counties has generated growing pressures on the land. The population grew from 71,500 in 1940 to 174,500 in 1960—an increase of about 240 percent. The creation of new jobs in the area naturally drew more people, and these people needed and wanted homes, schools, parks, playgrounds, and golf courses. Approximately 14,000 new homes were constructed between 1950 and 1960. The land used for urban and industrial sites increased from about 20,000 acres in 1950 to 32,000 acres in 1960. Location of these urban and industrial areas seems to have just "happened" with little or no planning or consideration of possible implications for the coming years.

Soils for different purposes

In the Davis-Weber area the upland gravelly and sandy soils that occur on the sloping topography along the base of the Wasatch Mountains are usually droughty and somewhat difficult to manage for crops, but

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THE STATUS OF OUR FEDERAL GRANT LANDS

E. BOYD WENNERGREN and N. KEITH ROBERTS

IN ADDITION to granting statehood to Utah, the Enabling Act of 1898 also provided for a federal grant of public domain land. Under this act, federal lands were transferred to the state to provide economic support for specified public needs and institutions.

Major among the grant purposes was support of the common school system. Of the approximately 7.5 million acres conveyed to Utah, 5.8 million were for support of public education (table 1). These lands were specifically identified as sections 2, 16, 32, and 36 of each surveyed township. In addition to this grant, other lands were conveyed for other educational facilities, public institutions, and miscellaneous needs.

The Enabling Act also provided for management of these lands, including the establishment of a State Land Board to act as custodian of this public asset. Provisions were made for sale of these lands where such disposition was deemed to be in the best interest of the state. Early state legislation prohibited the sale of either surface or sub-surface rights to lands of known coal or mineral deposits. Sale of lands not so classified conveyed both surface and subsurface rights to the purchaser. However, subsequent legislation has altered conditions relative to the acquisition of surface and subsurface rights. Since 1919 all subsurface rights have been reserved from sale, but all surface rights have been left subject to sale contingent on the discretion of the State Land Board.

Today, Utah's grant lands represent an important state asset even though the original holdings have been reduced. During the years since statehood much of the original grant land has been disposed of through sale to private ownership and in limited instances to public agencies. In 1960, the State Land Board controlled 2,985,200 acres (fig. 1). These figures are believed to approximate closely the current land holdings since only limited sales and restricted acquisitions have occurred since 1960. Of this amount, approximately 2.7 million acres was located within Bureau of Land Management (BLM) grazing districts. State lands are located in each of Utah's 29 counties. The heavier populated counties of Salt Lake, Weber, and Cache contain an aggregate of only 17,981 acres. Utah and Box Elder Counties contain larger amounts, but many of the lands are located in the less populated sections of the counties, particularly in Box Elder. State grant lands are most common in Millard, San Juan, Emery, Grand, and other more

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DRS. WENNERGREN and ROBERTS are members of the Department of Agricultural Economics. This article is the first in a series reporting research conducted during the past three years on problems related to Utah's grant lands.

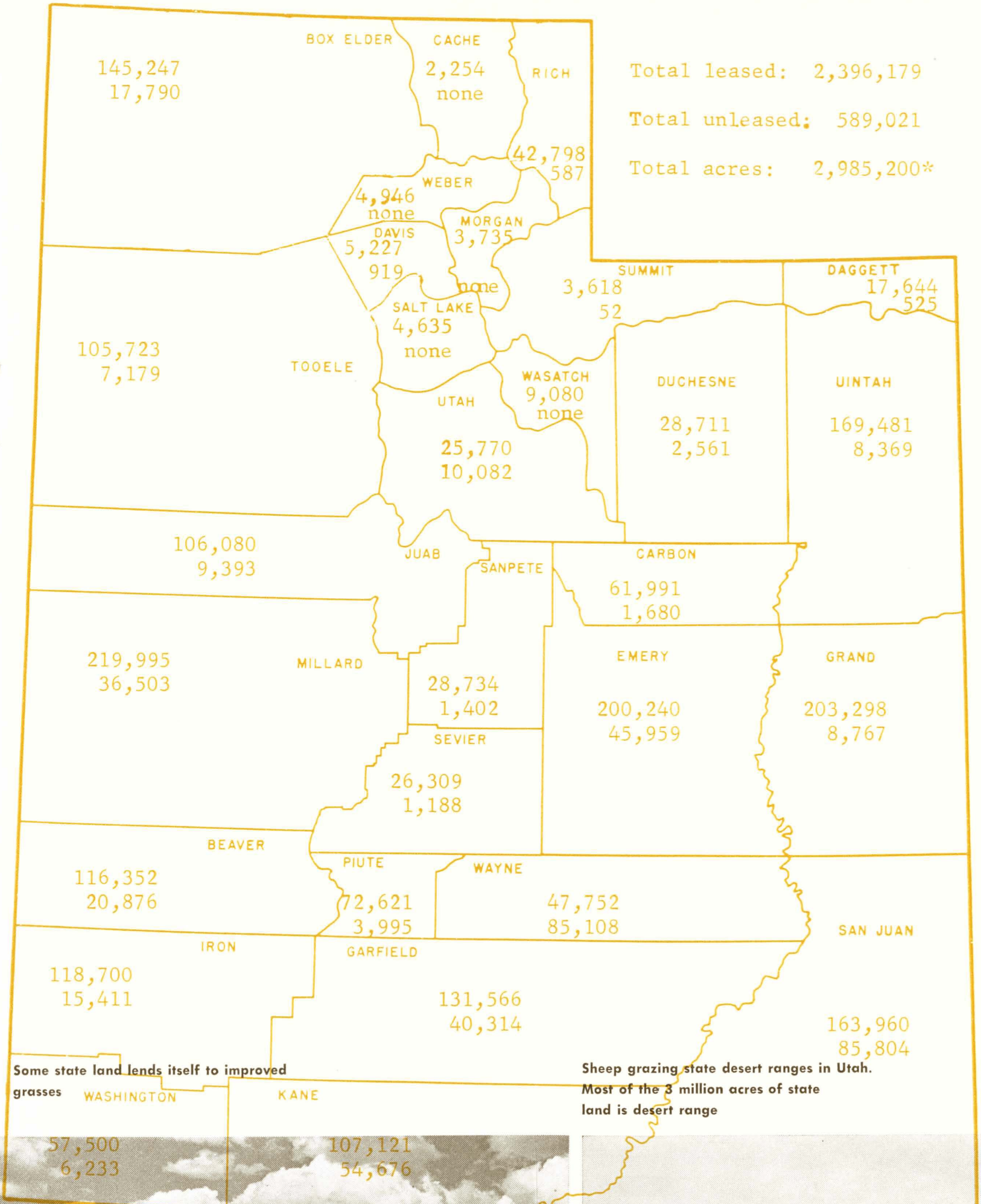
Table 1. Federal land grant to state of Utah

Purpose of grant	Area granted	Percent of total
	acres	
Agricultural college	200,000	2.6
Normal school	100,000	1.3
School of Mines	100,000	1.3
University - old grant	46,141	*
new grant	110,000	1.5
Common schools	5,844,196	77.8
Total educational grants	6,400,337	85.3
Deaf and dumb asylum	100,000	1.3
Insane asylum	100,000	1.3
Institute for blind	100,000	1.3
Miners hospital	100,000	1.3
Reform school	100,000	1.3
Penitentiary	160	*
Total institutional grants	500,160	6.6
Public buildings	64,000	*
Reservoirs	500,000	6.6
Carey acts	37,240	*
Total other grants	601,240	8.0
TOTAL ALL GRANTS	7,501,737†	100.0

*Less than 1%

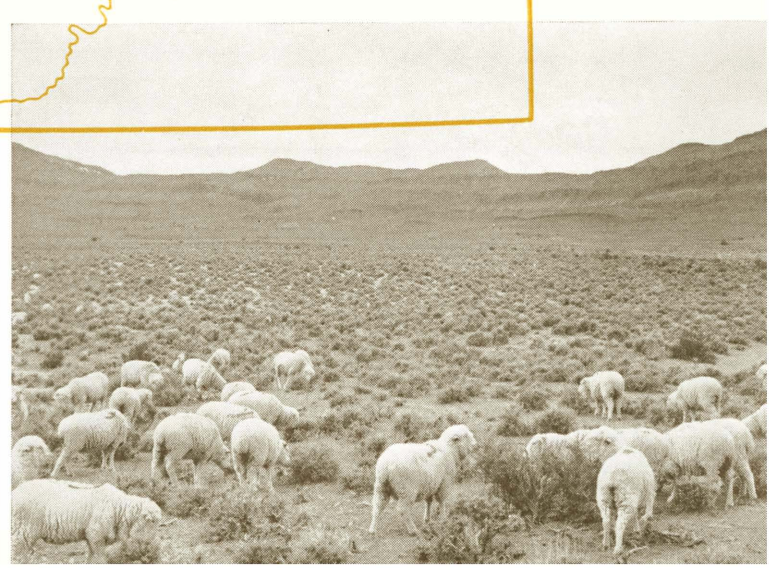
†Does not include grant of navigable lakes and streambeds.

Source: Laurence A. Reuss and George T. Blanch. Utah's land rescoures. Utah Agr. Exp. Sta. Spec. Rept. 4. 1951.



Leased (upper figure) and unleased (lower figure) state lands by county

Some state land lends itself to improved grasses



Sheep grazing state desert ranges in Utah. Most of the 3 million acres of state land is desert range

REDUCING FRUIT TREE BREAKAGE

DAVID R. WALKER

FRUIT growers are continually confronted with the problem of how to prevent large limbs from being broken from their trees. Serious and costly losses occur each year in many orchards. Often times a third or a fourth of a tree is lost, which when considered over its remaining life may involve many bushels of fruit. When a large limb breaks off it may split down the trunk leaving an area exposed for entrance of disease organisms.

Breakage is usually caused by strong winds, careless pickers, and heavy fruit crops. These causes are difficult to eliminate hence, it is easier to study methods of preventing them.

Methods of preventing breakage

Young trees: Proper selection of main scaffold limbs the first year or two the trees are in the orchard is important in preventing future breakage. All fruit trees, with the possible exception of peaches, should be trained by the modified leader system. This involves selecting three or four desirable young limbs with the lowest one being 18 to 20 inches from the ground and prefereably on the south west side in order to protect the trunk from the winter and early spring sun. The other limbs should then be selected at 6 to 10 inches apart arranged around the trunk so one is not directly over another one. The remainder of the young limbs eventually should be eliminated, although they may be left for a few years if the procedure discussed below is followed. When trees are trained in this manner the lowest limb is high enough for cultivating and mowing equipment to pass underneath, yet it is low enough so it can be picked fairly easily.

Trees will grow larger, have an increased bearing capacity, and can withstand heavier fruit loads and more wind if: (1) Limbs are not allowed to develop adjacent to each other on the trunk, and (2) The limbs form wide angles (up to 90 degrees from the trunks). If limbs are allowed to develop near each other on the trunk they often "choke out" or greatly weaken the top of the tree. The vascular system supplying nutrients and water is often unable to supply the top of the tree properly.

It is not only important to have wide angled limbs from the trunk for a wider tree, hence more bearing capacity close to the ground, but also to permit the annual growth to occur without bark inclusions in the crotches. Bark inclusions are bark which has been covered up with new growth. The bark prevents proper union, dies, and rots leaving the limb much more susceptible to breakage.

The three or four wide angled branches should be selected during the first year or two the trees are in the orchard. A method used to force these branches to develop or remain at wide angles to the trunk is to prune each of the remaining branches back to about $\frac{1}{3}$ or $\frac{1}{2}$ of its size after the first season's growth. This is done so they will not compete as much for nutrients and will allow the main limbs to become dominant. Each new shoot which develops on these limbs is pruned heavily each spring allowing only 3 - 5 inches of growth to remain. The large number of these shoots which develop after a few years from each limb force the desired limbs to grow more at right angles than they would otherwise. These "spacer limbs" are removed after the trees start bearing well. The weight of the fruit keeps the limbs from growing upright at that time.

Mature trees: Developing limbs at intervals around the trunk at different heights or training limbs for wider angles is not possible on older trees, but there are still some possibilities for reducing breakage.

Large bolts have been used between two limbs to prevent breakage. Wire bracing with eye bolts or screws has also been effective. Although these methods are effective they take considerable time in boring holes for bolts and tightening wire. Another disadvantage, is that their effectiveness is limited to limbs through which the bolts are placed and does not protect other limbs on the tree unless a number of bolts are used.

Banding fruit trees

Large packages and boxes have been banded with steel strapping for years and now growers are using these materials to tie trees together and prevent breakage. Wide ($\frac{3}{4}$ inch) galvanized steel strapping material is available which has sufficient

(*Continued on page* 28)

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Fig. 1. Crotch splitting of a peach tree. If the breakage of this type is noticed soon after the split the limbs can be saved by using the new banding method described

Fig. 2. One-third of this sour cherry tree has been split off the trunk, leaving remaining portions exposed to disease organisms and winter injury. A bolt has saved only two of the limbs

Fig. 3. Banding a sour cherry tree which was poorly trained

Graduate student operating the computer in solving a genetics simulation problem

COMPUTERS SPEED RESEARCH

REX L. HURST and LOIS COX

INCOMPREHENSIBLE electronic monster? Hardly! The research scientists at USU who have already benefited from its work seem more inclined to see the IBM 1620 computer as an angular angel.

The computer has brought greater capacity and precision to the processing of data on every facet of research. Even a relatively simple experiment can involve hundreds of samples and necessitate thousands of measurements and observations. The innumerable possible interrelations among such data were rarely explored in depth when the scientists had access only to an adding machine or a standard calculator. Data processing systems have proved to be veritable Aladdin's lamps under these circumstances. As statistical techniques have been improved and have facilitated the taking of larger quantities of meaningful data, computers such as the 1620 at USU have simultaneously made it possible to interpret and correlate the mass of data with fantastic speed and thoroughness.

Few people except a specially trained maintenance man may understand the mechanics of its inner workings, but this doesn't limit the 1620's usefulness. Since it was purchased in June 1961, the research data processed through the 1620 has far exceeded what was handled earlier — both in quantity and precision. Also, in this space and electronics age, more and more industries are actively seeking personnel who understand the use of high-speed computers. Adding the 1620 to USU's arsenal of automatic data processing equipment has permitted more comprehensive training of students.

Man still indispensable

Data processing isn't a new concept for USU. The university has been using punch card eqiupment since 1949, and this same equipment now provides essential "background" support for the 1620. The new com-

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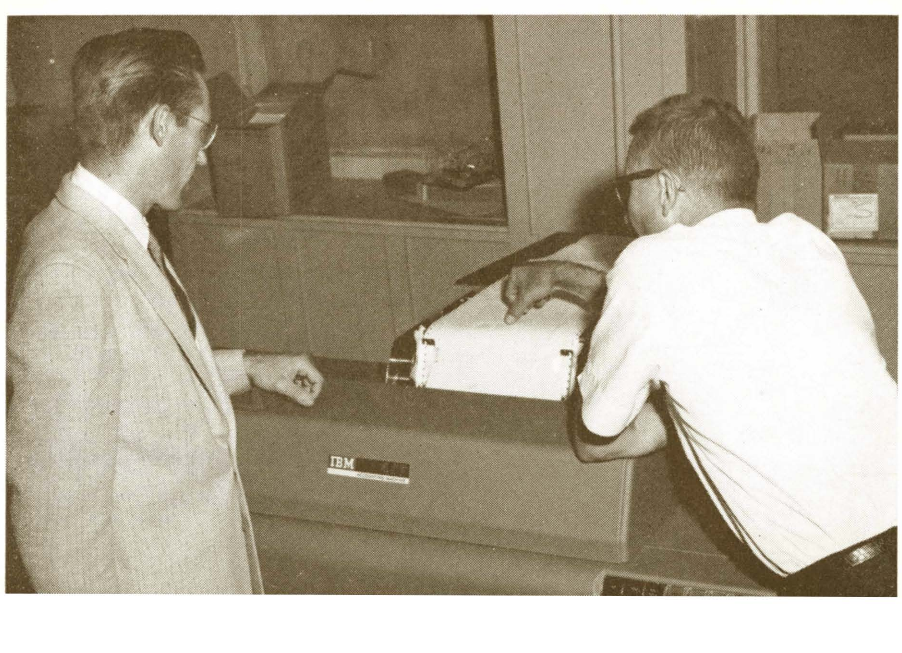
From top to bottom: Staff programmer analysing computer problem and developing the computer language expressions necessary for solving a scientific computing problem.

Key punch operator transcribing data from field records into punch card form.

Part of the professional staff going over the computer output and discussing the results with a view to improvement and interpretation



puter has tremendously augmented the system's capacity for arithmetic and logical work. Today as in 1949, however, all of the machines are only as useful as their operators make them.

If the original data are inaccurate or incomplete, no electronic gadget can rectify the situation. If the individual who puts the data in a form the machines can comprehend makes an error, the machines won't correct it. Data processing, the science of collecting, summarizing, and manipulating descriptive or numerical results of some endeavor has merely been speeded up by electronic know-how. The most important component remains the same as when all computations were done with paper and pencil—the human mind.

To the uninitiated it often seems that electronic "wonder machines" are about to make man obsolete. In learning how complex data processing equipment does its job, however, it quickly becomes apparent that man still holds the reins. Even the 1620 computer with its memory unit that comprises 40,000 digits of numerical storage can only do exactly as directed. And each direction must be clearly presented in a special machine language.

Research scientists at USU are learning to plan and design their experiments so they can take full advantage of the processing system's capacity. As they become more familiar with the limitations of the machines and the necessity for exceedingly careful pre-planning, they find they can learn more and more from a single experiment.

Preparation of data for the 1620

Current interest in computers raises a multitude of questions about their application to research. Before data from an experiment can be fed into the computer they have to go through the punch card equipment. And before they can start through the punch card equipment, they have to be coded. And before they can be coded, the experiment must be considered in terms of what data have been collected and what end information is desired. The initial step, then, when a researcher presents data, is to transform them into a flow diagram of the logic of the overall problem. Only then is it possible to begin thinking about putting the data on the punch cards which the processing equipment ingests.

In terms of research experiments, each card normally contains a unit record of information. This may be the complete information for a plot of ground in a field, an animal in a feeding lot, or the social behavior of a squirrel. Each card must be completely identified by using some combination of its total of 80 characters of information.

Although it is possible to use alphabetic codes, these are not as convenient as a numerical system. The next major step therefore involves converting descriptive material to numerical equivalents by setting up a code for the given experiment.

In devising workable codes it simplifies matters to think of the card as containing three basic types of information: reference, classification, and quantitative. The reference material identifies the card with the specific experiment, e.g., project, year, experiment identification, and plot number. Classification information recognizes characteristics of the experiment such as date of planting, variety identification, rate of planting, amount of fertilizer applied, and amounts of water applied. Quantitative information actually may be either quantitative or qualitative and could include: date of tasseling, height of plant, number of kernels per ear, moisture content at harvest, yield of grain, and protein content.

The card has subdivisions called fields. A field is one column or a group of columns used to record information of a given type. Each of the three types of information mentioned above may occupy one or more fields, and each field may involve one or more columns. An example of a coding system devised for a field experiment is shown in fig. 1.

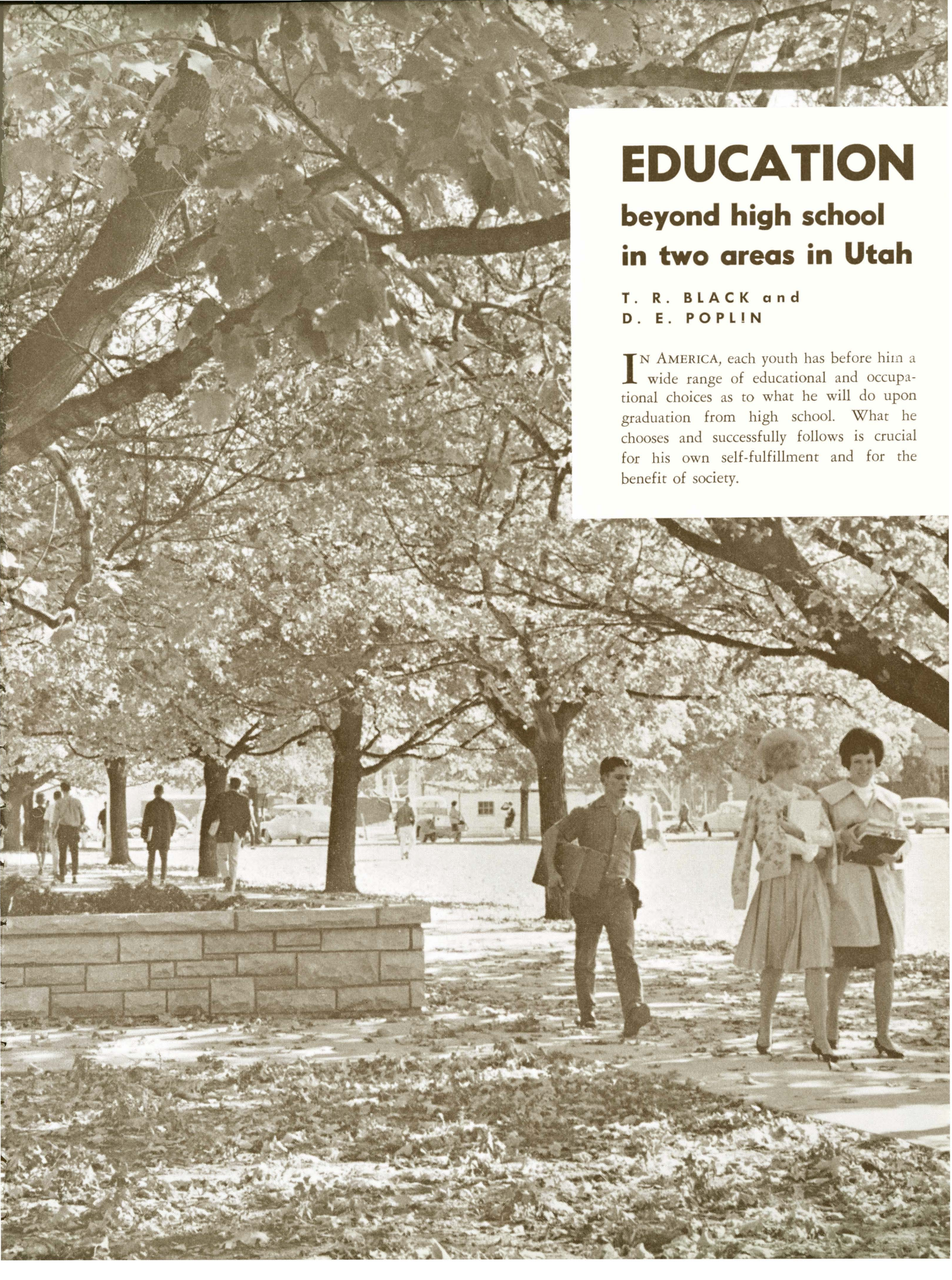
After the code is created and the data have been translated into the code, the punch card equipment comes into its own. At USU this equipment comprises six basic units. The *key punches* are used to transcribe information to punch card form. The *verifiers* check the work done by the key punches. The *sorter* arranges the cards in any desired sequence on any of the reference, classification, or quantitative information. The *collator* is a mechanical filing clerk. The *reproducer* is used to manipulate information from one set of cards to another set, and can add to or split records of information in any desired fashion. The *accounting machine* consists essentially of a reading unit, a write unit, and a set of counters for accumulating totals. It can add, substract, and make simple multiplications.

With a stack of coded cards, the researcher is ready to move on to the 1620. This computer has unbelievable arithmetic and logical ability. For example, in what is called fixed-point arithmetic, it can perform approximately 1200 to 1400 additions and subtractions per second, 300 to 400 multiplications per second, 50 to 100 divisions per second, and make up to 1200 logical decisions per second. With this high-speed arithmetic and logical ability it is possible to attack problems of tremendous complexity that would require literally months to solve with pencil and paper or weeks with the use of a desk calculator. For example, the

(*Continued on page* 27)

Figure 1. Coding system illustration

Card columns	Field identification	Coding
(1-4)	Project number	Actual number
(5-6)	Year	Last two digits of year
(7-8)	Experiment number	Actual number
(9-11)	Plot number	Actual sequence number
(12-13)	Replication	Actual number
(14-16)	Planting date	Day of year
(17)	Variety	1=Golden Cross bantum
		2=FM cross
		3=Golden Beauty
(18)	Planting rate	1=Hills, 2 ft. centers
		2=Hills, 3 ft. centers
(19)	Fertilizer rate	0 - None
		1 - Twenty pounds per acre
		2 - Forty
		3 - Eighty
		4 - One hundred sixty
(20)	Irrigation	1 - Two 4 inch
		2 - Four 3 inch
(21-23)	Tasseling date	Day of year
(24-26)	Height of plant at harvest	Inches
(27-29)	Number of kernels per ear	Number
(30-32)	Moisture percent of grain at harvest	Percent, xx.x
(33-35)	Yield of grain	Pounds per plot, xx.x
(36-38)	Yield of dry matter	Pounds per plot, xxx



EDUCATION

beyond high school in two areas in Utah

T. R. BLACK and
D. E. POPLIN

In America, each youth has before him a wide range of educational and occupational choices as to what he will do upon graduation from high school. What he chooses and successfully follows is crucial for his own self-fulfillment and for the benefit of society.

The choices each youth makes are influenced by the extent to which his community and his school have helped him to develop his inner resources. Rural and urban areas often show differences in such development. Particularly, rural areas with diminishing economies and populations may set poor records in youth development.

What is happening to Utah's rural youth? How do their educational patterns compare with those of other youth in the state? How do youth in declining and expanding areas of the state compare in educational pursuits?

To answer these questions data were gathered by a survey of high school graduates in Box Elder County and in the Sevier River Basin counties of Sanpete, Sevier, Millard, Piute, and Garfield. These two areas represent two positions on the rural-to-urban continuum: Sevier Basin is a population-declining rural area, while industrializing and urbanizing Box Elder County is a population-increasing area.

Youth go to college and trade school

More than half the high school graduates in the two areas went to college or trade school. Information was gathered about the graduates of three sample years, 1950, 1955, and 1960. In the Sevier River Basin counties 57.5 percent of those graduates attended college, trade school, or both, at some time after graduation from high school. In Box Elder County, 56.1 percent of the graduates had done the same.

There has been a tendency for rates of attendance to rise from one five year period to another and over the decade as a whole. In the Sevier Basin counties, the increase was from 54.7 percent in 1950, to 57.5 percent in 1955, to 60.1 percent in 1960.

The same picture characterizes Box Elder County, although the rate for 1955 was somewhat lower than in 1950. The increase was from 54.5 percent in 1950 through 53.8 percent in 1955, to 59.1 percent in 1960.

Rates of college attendance

Half of the Box Elder and nearly 47 percent of the Basin graduates attended college. These proportions are high when compared to other states. One careful observer estimated that about 40 percent of the nation's males and 27 percent of its females go to college following high school graduation, an average of about 33 percent if we ignore variations due to sex. A Kansas study found that 41 percent attended college. In Michigan around the middle of the last decade, 29 percent of the graduates of the previous year were attending college. A recent study from Arkansas indicated that 26 percent of her high school graduates continued on to college.

Rates of trade school attendance

Trade schools are assuming a greater role in the education of our young people. The lowest paid male job holders tend to be operatives and kindred workers, unskilled laborers, and farm labor. Among the highest paid are the professional, technical, and the skilled workers. Trade school functions primarily to prepare workers for the higher paying skilled jobs. The disadvantaged position of persons in unskilled job categories lies not only in low remuneration, but in the greater possibilities of unemployment. Clearly the youth who can aquire skills enough to boost him into the skilled labor class is less vulnerable to the pitfalls of unemployment. Also, he is able to avoid the stigma which modern society attaches to the person with no technical skills.

The increasing importance of trade schools to young people is illustrated in the slight but significant increase in trade school attendance between 1950 and 1960. Between these years, the rates of trade school attendance by high school graduates in the study rose from 8.7 to 15.6 percent in the Basin counties and from 4.1 to 7.2 percent in Box Elder.

The Sevier Basin youth has found it more difficult both financially and ecologically than his Box Elder counterpart to obtain some form of post-high school education.

Financial differences

In 1950 the average Sevier Basin income was around $2200 as compared to about $2800 in Box Elder County. At the end of the ten-year period the figures were approximately $4100 and $6100, respectively. Thus, meeting the costs of higher education was more difficult for Basin residents. A recent survey of costs at 46 state universities revealed that in 1960 the median for student expenses was $898 with a range from $675 to $1,170. Another expert puts the figure at $1500 to $1700. The Sevier Basin family would be required to spend about one-fourth of its year's income to send a student to college while the average Box Elder County family could achieve the same goal with approximately one-sixth of its yearly earnings.

The young person in the Sevier Basin lives a greater distance from the nearest college or trade school, while Box Elder County students live within easy commuting distance of two major training areas, Logan and Ogden. Snow College in Ephraim is the only facility within the Sevier River Basin, and even it is not central to many of the major population clumpings in the area. It has been calculated that a Sevier student lives an average distance of 44 miles from this facility, while the average Box Elder student lives only 22 miles away from Utah State University and 20 miles from Ogden. Of the Box Elder graduates under study, 23 percent had lived at home

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during the first period of attendance at college or trade school. By saving board and room costs, a commuter can reduce the financial outlay.

Effort compared

The greater financial effort required by Sevier Basin graduates to obtain some form of higher education might be expected to act as a strong deterrent to this goal. This, however, is not apparent. In fact, the Sevier Basin counties had a larger percent of graduates enrolling in college and trade schools than the more advantaged Box Elder graduates.

Possibly students of the Basin have been highly motivated, seeing such action as the only effective means out of an economic dilemma facing them. In the Sevier River Basin area family and individual incomes are below the state average; there is relatively little employment opportunity and a great amount of unemployment, and various institutions are experiencing difficulties of participation and finance. These conditions are reflected in and have likely caused the considerable amount of outmigration which has characterized the area during the last few years.

The total percentage of population in the labor force in the Sevier area has always been considerably lower than in Box Elder County. In 1960, 6.5 percent of the Basin labor force and 2.3 percent of the Box Elder County labor force were unemployed. Such facts again would seem to create a less favorable setting for achieving some post-high school education by rural youth. Yet the fact that a large portion of graduates in this study seek post-high school training shows decided motivation. Possibly such motivation could be the knowledge that satisfactory jobs are not available in the home area, and that successful migration from the country involves the acquisition of skills, training, and education beyond high school.

However, this explanation cannot wholly account for the high rates of attendance in spite of seeming handicaps, for the acquisition of skills could have come from the trade schools alone. We have seen that nearly half the graduates of this study from the Basin area went to college, where there is a greater opportunity to receive broader cultural values—values which motivate young people to seek education partly as an end itself independent from its occupational worth. The high rates of college attendance in both areas bespeaks of some such social influence at work.

OUR LIMITED RESOURCES

(*Continued from page* 11)

Management on rangelands must be intensified to overcome decreased acreages due to other demands for the range. Vegetation manipulation by seeding, fertilizing, and spraying weedy species can be used to increase livestock production and to create habitats favorable to big game and upland game birds.

Today we hear much about the recreation needs of people. As populations increase and as man lives more intensively people undoubtedly will feel more need for relief from daily routine.

Recreation is an established use for natural resources, and we are already in the act of committing large areas of our state permanently and exclusively to recreational purposes. But space for recreation, especially wilderness types of recreation, becomes a problem as the demands for use of our land increase in variety and vigor. Wilderness recreation is an inefficient use of land, perhaps a luxury we cannot longer afford. We need to know more of the real *needs* of man for recreation — contrasted with his desires. Then we need to know how to maximize the recreation yield per acre of ground and to develop it at minimum expense to other land uses. The sanitation problem connected with recreation on watersheds needs study. We need research on highway and access road construction to allow people to get into back country with minimum disturbance to the land resources.

We need to emphasize repeatedly that overproduction and abundance are only temporary. Sooner than we may realize, demands for almost all natural resources will exceed supplies. Our food, our clothes, our health, and our enjoyment of life in the future depend upon the research of today. Utah scientists and others throughout the world will be able to solve these problems if given support to continue and to expand basic research.

ZONING

(*Continued from page* 13)

they have advantages for urban and industrial developments. They provide stable foundations, good drainage for septic tank fields, and can support the growth of lawns and shrubs.

Some of the upland soils on the steeper foothill slopes of the mountains have a real aesthetic value for the home builder. The steeper slopes do create construction problems, but these are secondary in the minds of many home seekers.

The soils that are best suited for agricultural use in this area are the deep loamy soils that have good drainage. These occur on the nearly level and gently sloping topography of the higher lake terraces. Such soils, however, are also favored by builders because they present so few limitations to large scale housing and industrial construction. Thus, they may be ranked as most susceptible to immediate population pressures.

The deep, moderately well-drained soils that occur on the nearly level and gently sloping intermediate lake terraces usually have a ground water table that is about 3 to 5 feet deep. These soils are generally useful for most crops and can also be used as home sites. They can be improved at comparatively small costs by installing drainage facilities and when drained, are even better suited to a wide variety of uses.

The imperfectly and poorly drained soils of the low lake terraces and flood plains have water tables that are usually within 20 to 36 inches of the ground surface. As they exist naturally, these soils have serious limitations for crop production and are used only to a minor extent for buildings. Many areas of these soils could be drained, however, and then they would be well suited for many crops as well as for lawns, flowers, and shrubs.

Some of the soils on the low lake terraces are affected with salt and alkali in addition to having high water table problems. These soils are difficult to drain and reclaim and are undesirable for either urban development or crop production. They have limited agricultural value as pasture, but could be adapted to some industrial purposes.

Poorly drained soils have a water table near the surface and usually occur in depression areas where it is not economical to drain. These soils are avoided for both urban use and crop production, but they have some value for forage.

The poorly drained salty soils of the lake plain are not suitable for either crop production or for urban developments other than limited use for industrial purposes. They have a limited value for forage production and as wildlife habitat.

Soil types and areas vary in different parts of the state. Fundamentally, however, the problems are the same. Population pressures continue to grow while land acreages remain stable. Zoning, based on factual data such as that supplied by soil surveys, offers one way to implement plans for the future efficiently.

FEDERAL GRANT LANDS

(*Continued from page* 14)

arid and less populated counties.

In addition to the lands currently controlled by the Board, states entitlement also exists for grant lands withdrawn by the federal government for various purposes. These "lieu lands" can be reclaimed by the state anywhere within the public domain, subject to certain restrictions which attempt to insure the acquisition of land of similar character. The state's lieu land entitlement has been estimated to be approximately 600,000 acres.

Revenues:

Of the total lands held, 2,396,179 acres (or 80 percent) were under lease in 1960. Of these 2,231,088 acres were leased within BLM grazing districts. Total grazing leases returned an annual revenue of $112,276 to public school support (table 2). These revenues represented approximately 7 percent of the total revenues received for the year. In addition, they constituted the fourth largest source of Board revenue and the most important return from surface uses. Returns from rights-of-way and timber sales represented only about one percent of the total. Investment of sale funds in bonds and GI and FHA loans returned substantial interest revenues as did sale of lands on time contracts. Returns from mineral development and exploration represented the most important current source of income, totaling approximately $1.3 million from rental and royalty payments. Much of this, however, was from mineral rental which reflects the current interest in oil and mineral exploration throughout the state.

Grazing fee revenues amounted to an average of 4.7 cents per acre for the acreage under lease (table 3). Average fees varied among counties, ranging from a high of 27.9 cents per acre in Salt Lake County to 2.7 cents per acre in Wayne County.

Fees were not closely related to the carrying capacity of the land. Carrying capacity is defined in terms of the number of acres per animal unit month (AUM). Since state lands are scattered throughout the

Table 2. Revenues to State Land Board, by major source, 1960

Sources of revenue	Returns	Percent of total
	dollars	percent
Mineral leases:		
Rental	1,078,210	63.2
Royalty	200,557	11.8
Interest:		
Bonds	225,565	13.2
FHA and GI loans	30,139	1.8
Land sales	25,797	1.5
Contract loans	3,134	.2
Other loans	9,458	.6
Grazing fees	112,276	6.6
Timber sales	12,673	.7
Rights-of-way	5,308	.3
Profit on resale of forclosures	2,275	.1
TOTAL	1,705,392*	100.0

*This total is not conclusive since minor sources of income are not included.

BLM areas, carrying capacities suggested by the BLM for proper long run management were used to develop those for state grant lands. As can be seen in table 3, the average fee in Beaver County was 3.0 cents per acre with an average carrying capacity of 9.6 acres per AUM. However, in Duchesne County where the average carrying capacity was 16.4 acres per AUM, fees averaging 6.0 cents per acre were received. The lack of a consistent relation between fees and carrying capacity was demonstrated by a correlation analysis which indicated that only 1 percent of the variation in fees was associated with variations in carrying capacity.

Grazing capacity

The average carrying capacity for state lands was estimated at 15.5 acres per AUM (table 3). Much of the lower capacity land is located in the arid southeastern section of the state. The average ranged from 6.0 acres per AUM in Davis, Cache, and Weber Counties to a low of 26.7 acres per AUM in San Juan County. Grand, Wayne, and Kane Counties also contain considerable lands of low grazing capacity. Grazing capacities for individual county sub-units ranged from a high of 5.5 acres per AUM in the North Grouse Creek area of Box Elder County to a low of 60.6 acres per AUM in the Book Cliffs Unit in Grand County.

These grant lands, including their present contents and future potentials, constitute an important asset to the support of the state's educational system and other public institutions. They provide the basic resources from which revenues can be generated to support these selected public needs. Consequently, management decisions and policies are of vital concern.

Table 3. Suggested carrying capacity and grazing fees for state lands, by county, 1960

County	Suggested carrying capacity	Carrying capacity range for BLM sub-units in county	Average grazing fees
	acres per AUM	acres per AUM	cents/acre
Beaver	9.6	7.3 - 23.8	3.2
Box Elder	12.4	5.5 - 19.0	4.1
Cache	6.0	6.0 - 6.0	11.6
Carbon	16.3	13.3 - 22.9	6.6
Daggett	9.8	9.3 - 10.0	6.7
Davis	6.0	6.0 - 6.0	11.6
Duchesne	16.4	12.6 - 22.9	6.0
Emery	18.0	12.3 - 27.4	3.2
Garfield	17.1	10.3 - 25.8	2.8
Grand	23.0	9.6 - 60.6	6.2
Iron	14.5	7.3 - 38.3	3.6
Juab	13.5	11.0 - 25.7	3.6
Kane	17.9	8.9 - 25.8	4.0
Millard	15.0	8.2 - 25.7	3.1
Morgan	9.0	9.0 - 9.0	11.1
Piute	16.7	7.3 - 17.6	3.6
Rich	6.2	5.6 - 7.0	8.4
Salt Lake	12.0	12.0 - 12.0	27.9
San Juan	26.7	9.5 - 50.7	3.6
Sanpete	15.1	13.4 - 18.1	5.4
Sevier	16.7	15.4 - 21.7	4.5
Summit	10.0	10.0 - 10.0	19.1
Tooele	12.9	9.6 - 15.9	4.2
Uintah	12.5	6.3 - 19.8	4.3
Utah	10.8	10.2 - 20.0	8.8
Wasatch	12.0	12.0 - 12.0	10.3
Washington	17.1	8.6 - 25.0	3.7
Wayne	20.1	14.3 - 27.4	2.7
Weber	6.0	6.0 - 6.0	11.6
Average	15.5		4.7

CONTROLLING CURLY TOP

(*Continued from page* 5)

the highest levels of curly top resistance and have, consequently, greatly increased the efficiency of the breeding program and increased the chances of developing resistant varieties that stand up under all levels of curly top exposure. The type of

Table 2. Responses to curly top exposure of 3 groups of resistant breeding lines compared to those of resistant and susceptible check lines, 1961 and 1962

Line	Greenhouse		Field	
	H/T	%H	H/T	%H
Susceptible check	0/23	0	1/22	5
Owyhee	1/26	4	8/16	50
22C2	73/207	35	45/52	87
(25 x 28) 193	75/165	45	247/269	92
(45 x 28) 193	41/136	30	23/26	88

Table 3. Responses to curly top exposure of 3 groups of backcrossed resistant breeding lines compared to those of resistant and susceptible check lines, 1961 and 1962

Line	Greenhouse		Field	
	H/T	%H	H/T	%H
Susceptible check	0/184	0	5/106	5
Owyhee	5/209	2	2/3	67
22C2 x commercial	213/559	38	92/116	79
[(25 x 28) 193] com.	329/774	43	54/62	87
[(45 x 28) 193] com.	144/398	36	35/39	90

results obtained in field tests is illustrated in fig. 11.

Data obtained from greenhouse and field curly top tests the past two years are contained in tables 2 and 3. For simplicity the results of 1961 and 1962 were combined since they were similar. It can be seen from these results that the three series of pedigrees, 22C2, (25 x 28)193, and (45 x 28)193, have high levels of curly top resistance and that this resistance has been carried through backcrosses. The resistance is of a higher level than that currently available in commercial varieties such as Owyhee.

Crosses also resistant to verticilluim and fusarium wilts

In addditition to high levels of curly top resistance, most of this material also has resistance to verticillium and fusarium wilts. High levels of fruit setting ability, earliness, internal color, crack resistance, firmness, and small core have also been demonstrated by this material. Several of these excellent horticultural characteristics have apparently been derived unexpectedly from the wild, green-fruited species that were used as the sources of curly top resistance.

Some of the better looking plants in segregating progenies of the three most promising series of resistant lines are pictured in figs. 12, 13, and 14. A program of selecting and testing within such curly top resistant material should produce commercially acceptable lines. It should be possible to correct any horticultural deficiencies within lines by intercrossing resistant lines; and thus, to lessen the chances of a reduction in resistance which is often encountered when crosses are made to susceptible commercial varieties. The results of the past two years make it seem probable that commercial tomato varieties with high levels of resistance to curly top virus, verticillium wilt, and fusarium wilt will result from this program in the near future.

Fig. 12-14. Plants with good commercial type selected from curly top resistant progeny at Thatcher, Utah, in 1962. 12. Tomato line 22C2 x Com.[2]

13. Tomato line (25 x 28)193 x Com.[2]

14. Tomato line (45 x 28)193 x Com.[3]

COMPUTERS

(*Continued from page* 20)

computer has been used to solve sets of simultaneous equations of the order of 35 equations in 35 unknowns which would require approximately a year's time with human direct calculation. The computer can solve this set of equations in a little over 15 minutes. This capacity permits the testing and evaluating of complex mathematical models to see if they actually represent physical and biological situations.

The 1620's memory unit adds immeasurably to its potential. Each position in the memory is uniquely addressable, and the addresses run from 00000 to 39999. The memory unit thus involves 40,000 digits of numerical storage that can be used to store both instructions and data. In effect this unit is "wiped clean" whenever a new set of cards is started through, and is freshly available.

Before the 1620 can digest the researcher's cards and give him back the interpretations and correlations he wants, it has to be instructed what to do. A single instruction for the 1620 takes the form of a 12-digit number. The first two digits are an operational code, of which there are 35. Each of these 12-digit codes instructs the computer to perform a particular operation. For example, 21 is the code number for the ADD operation. The remaining 10 units of the 12-digit instruction are divided into two 5-digit fields. Each field may address a storage location in the computer where data, or another instruction, or the identification of one of the auxiliary devices the computer uses is available. For example, the instruction 210098300-841 would instruct the computer to go into location 841, acquire a number, take it, and add it to a number already stored at location 983. A series of these 12-digit numbers constitutes a program. A separate program usually has to be devised for each experiment to instruct the computer to perform whatever operations are necessary to accomplish the desired job.

Recording a large number of 12-digit instructions is tedious and therefore subject to a high degree of human error. For this reason computer companies have developed communication languages with which programmers can more easily communicate instructions to the computer. One of the more versatile of these scientific languages is called FORTRAN — short for FORmula TRANslation. In reality FORTRAN itself is a program, but one that has been written so that it will accept problem oriented language statements and convert them to the machine equivalent. After a professional programmer has mastered such a language he no longer has to cope directly with 12-digit numbers but instead can concentrate on solving the problem.

Sometimes a programmer creates a program that might be applicable to problems faced by other computer installations. Such a program is sent to a central library whose personnel abstract the information and transmit it to all computer users. This service gives USU access to the talents of many hundreds of programmers.

Practical applications

The data processing system of USU is currently being used extensively for both teaching and research. Students, whether aiming for careers in business or science, are coming to recognize the potential value of computer training as a promotion and salary determiner. Scientists from fields as diverse as animal nutrition and hydrology have seen it open new horizons of accuracy and magnitude.

One of its major applications in recent months has involved data from an experiment that ran for more than seven years. The study was designed to determine the effects of feeding various levels of fluorine to dairy cattle over a period of time. In pre-1620 days, the sheer mass of data accumulated would have been overwhelming and only a fraction of the possible interrelations could have been derived. With the 1620, however, it has been possible to correlate the extensive data and draw valuable conclusions that might otherwise have gone unrecognized.

The computer was used to confirm and quantify certain suspected relations and thus establish a basis for creating a diagnostic aid usable by practicing veterinarians. A veterinarian without previous experience with the effects of fluorine can now compare his findings in the field with the tabulated results of the USU experiment and estimate with reasonable accuracy how much fluorine the animals in question have consumed. The calculations that were a necessary preliminary to the design of this table would have taken years without the computer and might never have been completed. Use of the computer was also instrumental in facilitating correlation of fluorine content in one bone of an animal's body with that in another bone. In this case too, the necessary mathematical computations would have been prohibitive without the 1620. Even though the information had been taken, its full value probably would never have been realized.

It is obvious that the computer and its supporting equipment do not relieve the scientist-researcher of the necessity of planning and carrying out his experiments. The 1620 would have been of little value in the fluorine work if the data had not been painstakingly accumulated and organized from a carefully designed experiment. What the data pocessing system does do, however, is permit the investigator to analyze his results more fully and more quickly than he could before. In this way and by permitting USU to graduate better trained students, the 1620 is a real asset to the University.

Penalty for private use to
avoid payment of postage $300

Utah State University
Agricultural Experiment Station
Logan, Utah

Wynne Thorne
Director

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CONTRIBUTIONS TO RESEARCH
August 1, 1962 to February 1, 1963

National Institutes of Health	$57,000 for a spectral analysis of virus infection processes
	$26,488 for a study of the effects of radium on stream biota below uranium mills
	$17,488 for a study of infiltration of unsteady open-channel fluid flow
	$13,858 for a study of ascorbic acid and synthesis of collagen subunits
	$11,655 for the study of the effects of anionic detergent on aquatic biota
	$9,784 for a study of the genetics and diet in serum cholesteral biosynthesis
	$500 for a study of sialic acid distribution in the female genital tract
National Science Foundation	$34,070 for a study of the methodology for determining marginal valuations of water for alternative uses
	$6,500 for a study of activity coefficients of indicators and other molocules in concentrated acid solutions
	$5,600 for alkaloid biosynthesis and metabolism in the plant
	$4,000 for construction of three controlled environmental rooms in which temperature, humidity, and light can be controlled
	$3,800 for a study of the ethology of the North American quail
Esso Company	$10,000 for canal lining studies
American Chemical Society	$7,500 for a study of base-catalyzed acylative decarboxylation and gas-phase decarboxylation
Abbott Laboratories	$1,050 for improving the use of grains for poultry by the use of enzymes and antibiotics
American Cyanamid Company	$500 for study of miscellaneous insects
American Can Company	A semi-automatic vacuum closing machine with auxiliary equipment for use in research and teaching in food technology

FRUIT TREE BREAKAGE

(*Continued from page* 16)

strength to prevent large limbs from breaking. The material is economical, costing about one and a third cents per foot and six tenths of a cent for a clip to seal the strapping together. This would be less than ten cents per tree for the strapping material. Trees can be banded rapidly thus reducing labor costs. The bands are placed on the tree loose and add protection if the banches start to bend. If after a number of years the bands need to be loosened, this can be done easily if additional strapping is left for this purpose at the time of initial banding. Girdling caused by the strap has not been a problem. The wire is wide enough that girdling does not occur especially when it is left fairly loose. The whole tree can be banded inexpensively in this manner which appears much more effective and efficient than using bolts or wire. The tool used in tightening the strapping is capable of raising a large limb off of the ground and reuniting it back with the trunk. The limb will "knit" back on the trunk if the breakage is recent.

Propping large limbs is usually done to prevent the crop from breaking limbs just before harvest. This should still be done, since the banding is near the trunk and many limbs break away from the trunk as a result of a large crop. An effective prop is one by four inch native lumber with a "V" notch cut on one end. Many different sizes of these props are needed.

Pickers should be encouraged to use ladders and pick from the outside of the tree rather than taking chances and breaking limbs by climbing trees and going out on weak or heavily loaded limbs. Harvesting fruit without the use of ladders or not placing ladders properly also increases greatly the chance of falling from the trees.